New Hampshire Volunteer River Assessment Program

2003

COCHECO RIVER

WATER QUALITY REPORT

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

DECEMBER 2003

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STATE OF NEW HAMPSHIRE

Volunteer River Assessment Program

2003

COCHECO RIVER

Water Quality Report

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
P.O. BOX 95
29 HAZEN DRIVE
CONCORD, N.H. 03302

MICHAEL P. NOLIN
COMMISSIONER

HARRY T. STEWART
DIRECTOR
WATER DIVISION

Prepared by:
Ted Walsh, VRAP Coordinator
April Arroyo, VRAP Intern

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Cover Photograph: Upstream from Strafford County Farm Station (12-CCH), Dover

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2003 Cocheco River Watershed Volunteers

Lorie Chase, Coordinator
Linda Sherf, Dover Team Leader
Sandi Averill, Rochester Team Leader
Ed Mullen, Farmington Team Leader

Norma Bard
Anna Boudreau
Steve Brown
Art Corte
Melodie Esterberg
Joe and Marnie Gaudette
Kristen Henderson
Lauren Jacoby
Peter Keefe
Anne Melvin
Linda Scherf
Ann Schulz
Peter Seekamp
Sue Snow
Brian Stern
Jeff Winders

1. INTRODUCTION

1.1. Purpose of Report

Each year NHDES prepares and distributes a water quality report for each volunteer group that is based solely on the water quality data collected by that volunteer group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire surface water quality standards, and serve as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups. The purpose of this report is to present the data collected by the Cocheco River Watershed Coalition volunteers in 2003.

1.2. Report Format

Each report includes the following:

- ✓ **Volunteers River Assessment Program (VRAP) Overview:** This section includes a discussion of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- ✓ **Water Quality Parameters Typically Selected for Monitoring**: This section includes a brief discussion of water quality parameters typically sampled by volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- ✓ **Monitoring Program Description**: A description of the volunteer group's monitoring program is provided in this section including monitoring objectives as well as a table and map showing sample station locations.

- ✓ **Results and Discussion:** Water quality data collected during the year are summarized on a parameter-by-parameter basis using (1) a summary table that includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples of adequate assessment quality for each station, (2) a discussion of the data, (3) a list of applicable recommendations, and (4) a river graph showing the range of measured values at each station. Sample results reported as less than the detection limit were assumed equal to one-half the detection limit on the river graphs. This approach simplifies the understanding of the parameter of interest, and specifically helps one to visualize how the river or watershed is functioning from upstream to downstream. In addition, this format allows the reader to better understand potential pollution areas and target those areas for additional sampling or environmental enhancements. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- ✓ **Appendix – Data:** The appendix includes a spreadsheet showing the data results and additional information such as the time the sample was taken.

2. VOLUNTEER RIVER ASSESSMENT PROGRAM OVERVIEW

2.1. Past, Present, and Future

In 1998, the New Hampshire Department of Environmental Services (DES) initiated the New Hampshire Volunteer River Assessment Program (VRAP) as a means of expanding public education of water resources in New Hampshire. VRAP promotes education and awareness of the importance of maintaining water quality in rivers and streams. VRAP was created in the wake of the success of the existing New Hampshire Volunteer Lake Assessment Program (VLAP), which provides educational and stewardship opportunities pertaining to lakes and ponds to New Hampshire's residents.

Today, VRAP continues to serve the public by providing water quality monitoring equipment, technical support, and educational programs. VRAP supports over a dozen volunteer groups on numerous rivers and watersheds throughout the state. These volunteer groups conduct water quality monitoring on an ongoing basis. The work of the VRAP volunteers increases the amount of river water quality information available to local, state and federal governments, which allows for effective financial resource allocation and watershed planning.

The intent of VRAP is to educate people of all ages and backgrounds about river and stream water quality, the threats to water quality posed by increasing population, development and industrialization, and the ways in which we can all work together to minimize these impacts.

2.2. Technical Support

VRAP lends and maintains water quality monitoring kits to volunteer groups throughout the state. The kits contain electronic meters and supplies for "in-the-field" measurements of water temperature, dissolved oxygen, pH, specific conductance (conductivity), and turbidity. These are the core parameters typically measured by volunteers. However, other water quality parameters, such as nutrients, metals, and *E. coli* can also be studied by volunteer groups, although VRAP does not always provide funds to cover laboratory analysis costs. Thus, VRAP encourages volunteer groups to pursue other fundraising activities such as association membership fees, special events, in-kind services (non-monetary contributions from individuals and organizations), and grant writing.

VRAP typically recommends sampling every other week during the summer, and citizen-monitoring groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions. Each year volunteers arrange a sampling schedule and design in cooperation with the VRAP Coordinator. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency.

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine where improvements, restoration or preservation may benefit the river and the communities it supports. Water quality results are also used to determine if a river is meeting surface water quality standards. Volunteer monitoring results, meeting DES Quality Assurance and Quality Control (QA/QC) requirements, supplement the efforts of DES to assess the condition of New Hampshire surface waters. The New Hampshire Surface Water Quality Regulations are available through the DES Public Information Center at www.des.state.nh.us/wmb/Env-Ws1700.pdf or (603) 271-1975.

2.3. Training and Guidance

Each VRAP volunteer must attend an annual training session to receive a demonstration of monitoring protocols and sampling techniques. Training sessions are an opportunity for volunteers to come together and receive an updated version of monitoring techniques. During the training, volunteers have a chance to practice using the VRAP equipment and may also receive instruction in the collection of samples for laboratory analysis. Training is accomplished in approximately three hours, after which volunteers are certified in the care, calibration, and use of the VRAP equipment.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. VRAP aims to visit volunteers during scheduled sampling events to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group's monitoring coordinator is notified of the result of the verification visit. Volunteer organizations forward water quality results to the VRAP Coordinator for incorporation into an annual report and state water quality assessment activities.

2.4. Data Usage

2.4.1. Public Outreach/Water Quality Reports

All data collected by volunteers are summarized in water quality reports that are prepared and distributed after the conclusion of the sampling period (typically fall or winter). Each individual volunteer group receives copies of the report. The volunteers can use the reports and data as a means of understanding the details of water quality, guiding future sampling efforts, or determining restoration activities.

2.4.2. State Surface Water Quality Assessments

Along with data collected from other water quality programs, specifically the State Ambient River Monitoring Program, applicable volunteer data are used to support periodic DES surface water quality assessments. VRAP data is entered into NHDES's water quality database and is ultimately uploaded to the Environmental Protection Agency's database; STORET. Assessment results and the methodology used to assess surface waters are published by DES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act. The reader is encouraged to log on to the DES web page to review the assessment methodology and list of impaired waters http://www.des.state.nh.us/wmb/swqa/.

2.5. Quality Assurance/Quality Control

In order for VRAP data to be used in the assessment of New Hampshire's surface waters, the data must meet quality control guidelines as outlined in the VRAP Quality Assurance Project Plan (QAPP). The VRAP QAPP was approved by NHDES and reviewed by EPA in the summer of 2003. The VRAP Quality Assurance/Quality Control (QA/QC) measures include a six-step approach to ensuring the accuracy of the equipment and consistency in sampling efforts.

- **Calibration**: All meters are calibrated before the first measurement and after the last one. Prior to each measurement, the pH and dissolved oxygen meters are calibrated.
- **Duplicate Analysis**: A second sample is collected at the same time and station as the original sample. The duplicate analysis should not be conducted at the same station over and over again, but should be conducted at different stations throughout the monitoring season. At least 10% of all samples and measurements are duplicates.
- **Replicate Analysis**: A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. As with the duplicate analysis, the replicate analysis should not be conducted at the same station over and over again, but should be conducted at different stations throughout the monitoring season.
- **6.0 pH Standard**: A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.
- **DI Turbidity Blank**: A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.
- **Post-Calibration**: At the conclusion of each sampling day, all meters are calibrated.

2.5.1. Measurement Performance Criteria

Precision is calculated for field and laboratory measurements through sample duplicates (environmental variability) and measurement replicates (instrumental variability), and is calculated for each sampling day. The use of VRAP data for assessment purposes is contingent on compliance with a parameter-specific relative percent difference (RPD) as derived from equation 1, below. Any data exceeding the limits of the individual measures are disqualified from surface water quality assessments. All data that exceeds the limits defined by the VRAP QAPP are acknowledged in the data tables with an explanation of why the data was unusable. Table 2-1 shows typical parameters studied under VRAP and the associated quality control procedures.

(Equation 1)

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\ \%$$

where x_1 is the original sample and x_2 is the duplicate/replicate sample

Table 2- 1. Field Analytical Quality Controls

Water Quality Parameter	QC Check	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Temperature	Field duplicate; Measurement replicate	± 0.2 °C	Repeat measurement	Volunteer Monitors or Program Manager	Precision
Dissolved Oxygen	Field duplicate; Measurement replicate	± 2% of saturation, or ± 0.2 mg/l	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Instrument blank	± 2% of saturation, or ± 0.2 mg/l	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Relative accuracy
pH	Field duplicate; measurement replicate	± 0.1 std units	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Known buffer (pH = 6.0)	± 0.1 standard units	Recalibrate instrument repeat measurement	Volunteer Monitors or Program Manager	Accuracy
Specific Conductance	Field duplicate; measurement replicate	± 30 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Method blank	± 5.0 µS/cm	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Accuracy
Turbidity	Field duplicate; measurement replicate	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Precision
	Method blank	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteer Monitors or Program Manager	Accuracy

3. WATER QUALITY PARAMETERS TYPICALLY MEASURED BY VRAP VOLUNTEERS

3.1. Temperature

Temperature is one of the most important and commonly observed water quality parameters. Temperature influences the rate of many physical, chemical and biological processes in the aquatic environment. Each aquatic species has a range of temperature and other factors that best support its reproduction and the survival of offspring. Temperature can also impact aquatic life because of its influence on parameters such as ammonia as well as the concentration of dissolved oxygen in the water.

Temperature in Class B waters shall be in accordance with RSA 485-A:8, II which states in part "any stream temperature increase associated with the discharge of treated sewage, waste or cooling water, water diversions, or releases shall not be such as to appreciably interfere with the uses assigned to this class."

3.2. Dissolved Oxygen

Adequate oxygen dissolved in the water is crucial to the survival and successful reproduction of many aquatic species. Organisms such as fish use gills to transfer oxygen to their blood for vital processes that keep the fish active and healthy. Oxygen is dissolved into the water from the atmosphere, aided by wind and wave action where it tumbles over rocks and uneven stream beds. Aquatic plants and algae produce oxygen in the water, but this contribution is offset by respiration at night as well as by bacteria which utilize oxygen to decompose plants and other organic matter into smaller and smaller particles.

Oxygen concentrations in water are measured using a meter that produces readings for both milligrams per liter (mg/L) and percent (%) saturation of dissolved oxygen. For Class B waters, any single dissolved oxygen reading must be greater than 5 mg/L for the water to meet New Hampshire water quality standards. This means that in every liter of water there must be at least five milligrams of dissolved oxygen available for ecosystem processes.

More than one measurement of oxygen saturation taken in a twenty-four hour period can be averaged to compare to the standards. Class B waters must have a dissolved oxygen content of not less than 75% of saturation, based on a daily average. The concentration of dissolved oxygen is dependent on many factors including temperature and sunlight, and tends to fluctuate throughout the day. Saturation values are averaged because a reading taken in the morning may be low due to respiration, while a measurement that afternoon may show that the percent saturation has recovered to acceptable levels. Water can become saturated with more than 100% dissolved oxygen. It should be noted that other dissolved oxygen requirements in the New Hampshire Surface Water Quality Regulations (Env-Ws 1700) pertain to cold water fish spawning areas, impoundments (dams), and reservoirs.

3.3. pH

pH is a measure of hydrogen ion activity in water. The lower the pH, the more acidic the solution due to higher concentrations of hydrogen ions. A high pH is indicative of an alkaline or basic environment. pH is measured on a logarithmic scale of 0 to 14. NH rivers typically fall within the range of pH values from 6 to 8. Most aquatic species need a pH of between 5 and 9. pH also affects the toxicity of other aquatic compounds such as ammonia and certain metals.

New Hampshire Surface Water Quality Regulations (Env-Ws 1700) state that pH shall be between 6.5 and 8, unless naturally occurring. Readings that fall outside this range may be due to natural conditions such as the influence of wetlands near the sample station or because of the soils and bedrock in the area. Tannic and humic acids released to the water by decaying plants, for example, can create more acidic waters in areas influenced by wetlands. Low pH can also be due to atmospheric deposition of chemicals emitted by sources such as fossil fuel power plants and car emissions. When it rains, the chemicals in the atmosphere can lower the pH of the rain (commonly referred to as “acid rain”), which can, in turn, lower the pH of the river or stream. Acid rain typically has a pH of 3.5 to 5.5.

3.4. Specific Conductance

Specific conductance (informally termed conductivity) is the numerical expression of the ability of water to carry an electric current, and is a measure of the free ion content in the water. Water contains ions (charged particles) which can come from natural sources such as bedrock, or be introduced by human activity. The free ions carry an electrical current. Conductivity can be used to indicate the presence of chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum ions.

There is no numeric standard for conductivity because levels naturally vary a great deal according to the geology of an area. Conductivity readings are useful for screening an area to determine potential pollution sources.

3.5. Turbidity

Turbidity is an indicator of the amount of suspended material in the water, such as clay, silt, algae, suspended sediment, and decaying plant material. A high degree of turbidity can scatter the passage of light through the water, and inhibit light from reaching important areas. Clean waters are generally associated with low turbidity, but there is a high degree of natural variability involved. Rain events often contribute turbidity to surface waters by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. According to New Hampshire's Surface Water Quality Regulations (Env-Ws 1700), Class B waters shall not exceed naturally occurring conditions by more than 10 Nephelometric Turbidity Units (NTU).

3.6. Bacteria

Organisms causing infections or disease (pathogens) are often excreted in the fecal material of humans and other warm-blooded animals. *Escherichia coli* (*E. coli*) bacteria is not considered pathogenic. *E. coli* is, however, almost universally found in the intestinal tracts of humans and warm blooded animals and is relatively easy and inexpensive to measure. For these reasons *E. coli* is used as an indicator of fecal pollution and the possible presence of pathogenic organisms.

In fresh water, *E. coli* concentrations help determine if the water is safe for recreational uses such as swimming. According to New Hampshire's surface water quality standards, Class B waters shall contain not more than either a geometric mean based on at least three samples obtained over a sixty-day period of 126 *E. coli* per one hundred milliliters (CTS/100mL), or greater than 406 *E. coli* CTS/100mL in any one sample.

3.7. Total Phosphorus

Phosphorus is a nutrient that is essential to plants and animals, however, in excess amounts it can cause rapid increases in the biological activity in water. This may disrupt the ecological integrity of streams and rivers.

Phosphate is the form of phosphorus that is readily available for use by aquatic plants. Phosphate is usually the limiting nutrient in freshwater streams, which means relatively small amounts of phosphate can have a large impact on the biological activity in the water. Excess phosphorus can trigger nuisance algal blooms and aquatic plant growth, which can decrease oxygen levels and the attractiveness of waters for recreational purposes.

Phosphorus can be an indicator of sewage, animal manure, fertilizer, erosion, and other types of contamination. There is no surface water quality standard for phosphorus due to the high degree of natural variability and the difficulty of pinpointing the exact source. However 0.05 mg/L total phosphorus is typically used as a level of concern, which means DES pays particular attention to readings above this level.

3.8. Metals

Depending on the metal concentration, its form (dissolved or particulate) and the hardness of the water, trace metals can be toxic to aquatic life. Metals in dissolved form are generally more toxic than metals in the particulate form. The dissolved metal concentration is dependent on the pH of the water, as well as the presence of solids and organic matter that can bind with the metal to render it less toxic. Hardness is primarily a measure of the calcium and magnesium ion concentrations in water, expressed as calcium carbonate. The hardness concentration affects the toxicity of certain metals. Numeric criteria for metals may be found in New Hampshire's Surface Water Quality Regulations (Env-Ws 1700).

4. MONITORING PROGRAM DESCRIPTION

The Cocheco River Watershed Coalition became interested in exploring water quality in the river system further after preliminary water quality investigations in 1998 with DES Watershed Assistance staff. The Strafford Regional Planning Commission submitted a Local Initiative Program grant application to DES and was awarded funding to support a project coordinator and coverage for sampling in addition to the VRAP baseline parameters. The City of Rochester Public Works Department donates in-kind services including analysis for *E. coli* bacteria and an extremely valuable municipal partnership. The Volunteer River Assessment Program has provided field training, equipment, and technical assistance.

Twelve sites along the mainstem of the Cocheco River were monitored in 2003 from its upper limits in Farmington to the tidal dam in Dover. Four stations along the Mad River, a tributary of the Cocheco, were monitored once. Sampling station descriptions are provided in Table 4-1 and locations are shown on the foldout map on the following page.

Table 4-1. Sampling stations for the Cocheco River, NHDES VRAP, 2003.

Station ID	Location	Town/City	Elevation*
26-CCH	Central St. Bridge	Farmington	300
23-CCH	Watson Corner Rd. Bridge	Farmington	300
22U-CCH	Pike Industries	Farmington	300
22-CCH	Little Falls Bridge Rd.	Rochester	300
21-CCH	Rt. 202A Bridge	Rochester	200
19-CCH	Route 125 Bridge	Rochester	200
16-CCH	Upstream of Rochester WWTF Outlet	Rochester	200
15-CCH	England Road	Rochester	100
12-CCH	Strafford County Farm	Dover	100
11-CCH	Watson Rd. Bridge	Dover	100
10-CCH	Whittier St. Bridge	Dover	100
07-CCH	Central Avenue Bridge	Dover	0
03-MAR	River St. Bridge	Farmington	500
02-MAR	Rt. 11 Bridge	Farmington	400
01-MAR	Tappen St. Bridge	Farmington	300
00-MAR	Confluence with Cocheco	Farmington	300
02-ISG	Isinglass River, Rochester Neck Road	Rochester	100

*Elevations have been rounded off to 100-foot increments for purposes of calibrating the dissolved oxygen meter.

5. RESULTS AND DISCUSSION

5.1. Dissolved Oxygen

5.1.1. Results and Discussion

Either eight or nine measurements were taken in the field for dissolved oxygen concentration at ten stations on the mainstem of the Cocheco from Farmington to Dover. One sample was taken at four stations on the Mad River. (Table 5-1). All measurements but seven met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. Volunteers also deployed submersible meters (described below) to record dissolved oxygen at four stations in the Cocheco River watershed.

The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % of saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed as meeting dissolved oxygen standards.

Table 5-1. Dissolved Oxygen Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
26-CCH	9	7.92 - 9.92	0	8[a]
23-CCH	9	7.22 - 9.47	0	8[a]
22U-CCH	9	5.63 - 9.37	0	8[a]
22-CCH	9	5.92 - 9.22	0	9
21-CCH	9	4.61 - 8.31	1	9
19-CCH	9	6.83 - 9.3	0	9
12-CCH	8	7.07 - 10.21	0	7[b]
11-CCH	8	6.73 - 11.04	0	7[b]
10-CCH	8	6.89 - 10.49	0	7[b]
07-CCH	8	7.74 - 9.73	0	7[b]
03-MAR	1	10.39	0	1
02-MAR	1	10.1	0	1
01-MAR	1	9.41	0	1
00-MAR	1	10.25	0	1
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**83**

[a]No duplicate or replicate taken on 8/11/03
[b]No duplicate or replicate taken on 8/25/03

Dissolved oxygen concentration levels were above state standards on all occasions and at all stations except for one measurement at 21-CCH [Figure 5-1]. Stations where the instantaneous dissolved oxygen standard (5.0 mg/L) was not met could potentially have a dissolved oxygen problem.

Figure 5-2 and Figure 5-3 show the results of dissolved oxygen concentration and saturation levels obtained at four stations in the Cocheco River watershed using Hydrolab DataSonde 4a's. The meters were programmed to take dissolved oxygen readings every 15 minutes. Data from these meters is generally analyzed in 24 hour sections. During this deployment two 24-hour periods were measured. The daily average of dissolved oxygen % saturation was above the Class B standard of 75% at all four stations on both days of available data.

Figures 5-2 and 5-3 depict the typical cyclical variations in dissolved oxygen measurements one would expect to see during a 24-hour period in the summer. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.

During the summer of 2001, DES initiated a water quality sampling program to support the development of a total maximum daily load (TMDL) for the Cocheco River. This work is focused primarily on dissolved oxygen. The sampling stations that were established to support the TMDL coincide with the ones currently monitored by the Cocheco River Watershed Coalition. As noted throughout the document, DES recommends continued monitoring for dissolved oxygen and pH. Regarding dissolved oxygen, continued monitoring will benefit the public and DES by providing data before and after implementation of the TMDL. The Hydrolab data collected this year will be particularly helpful to the Cocheco River TMDL.

5.1.2. Recommendations

- Continue sampling at all stations; this will be helpful when evaluating the effects of implementing dissolved oxygen enhancements. Continued monitoring will benefit the public and DES by providing data before and after implementation of the TMDL.
- If possible, take measurements between 5:00 a.m. and 10:00 a.m., which is when dissolved oxygen is usually the lowest, and between 2:00 noon and 7:00 p.m. when dissolved oxygen is usually the highest.
- Continue to use submersible meters to automatically record dissolved oxygen.

Figure 5-1. Dissolved Oxygen Statistics for the Cocheco River
June 2 - September 22, 2003, NHDES VRAP

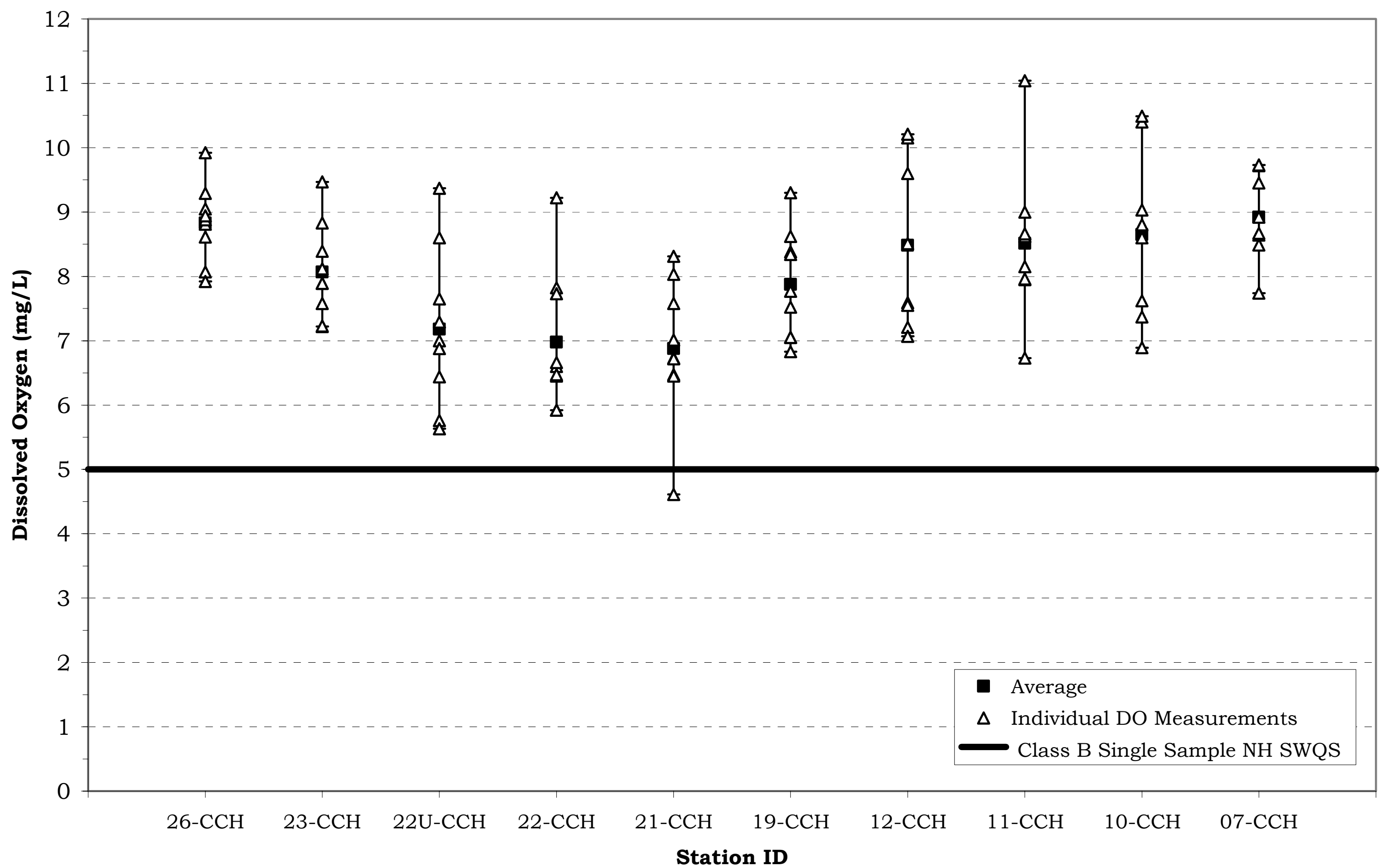


Figure 5-2. Dissolved Oxygen Saturation Statistics for the Cocheco and Isinglass Rivers July 30- 31, 2003, NHDES VRAP

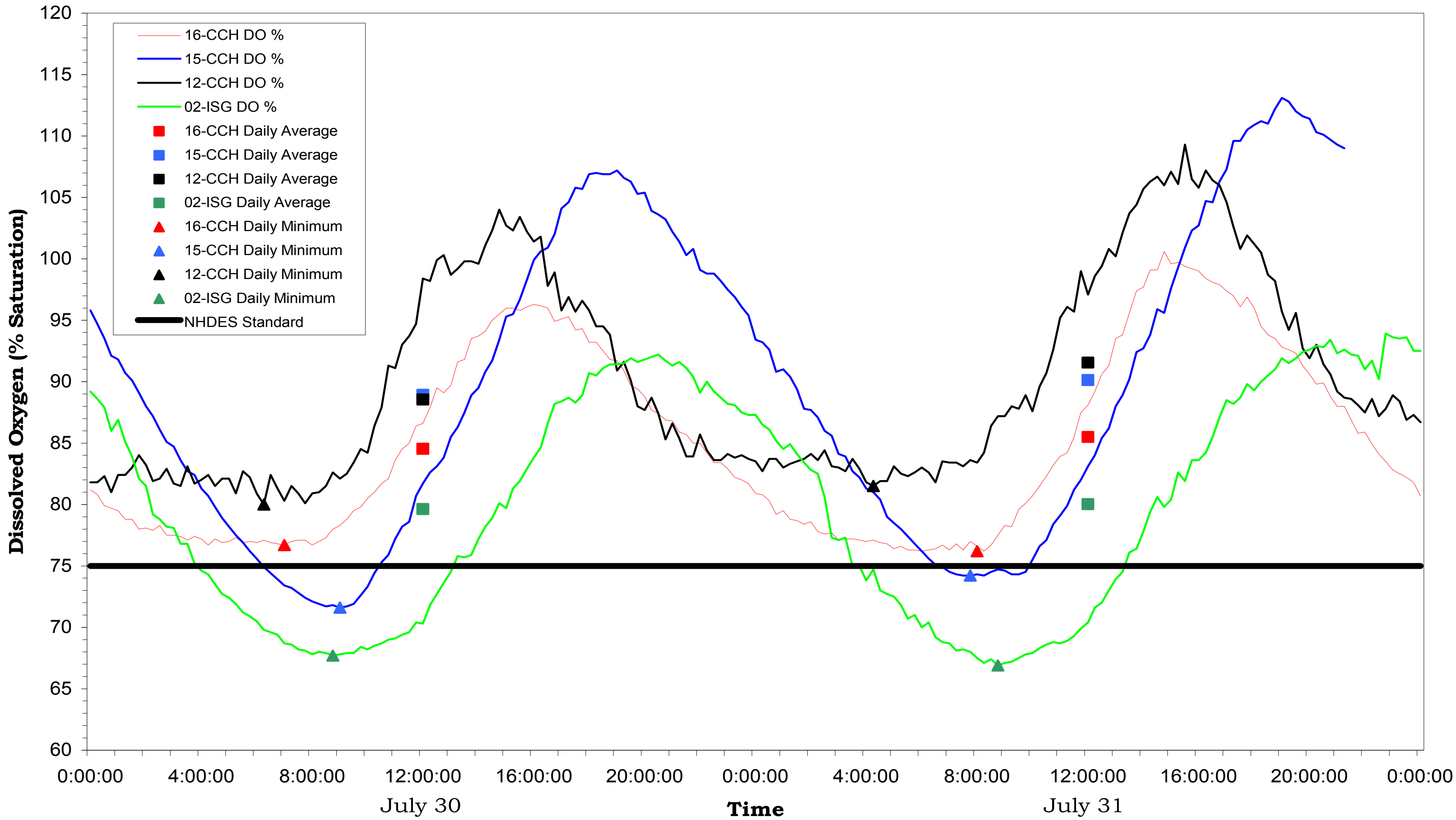
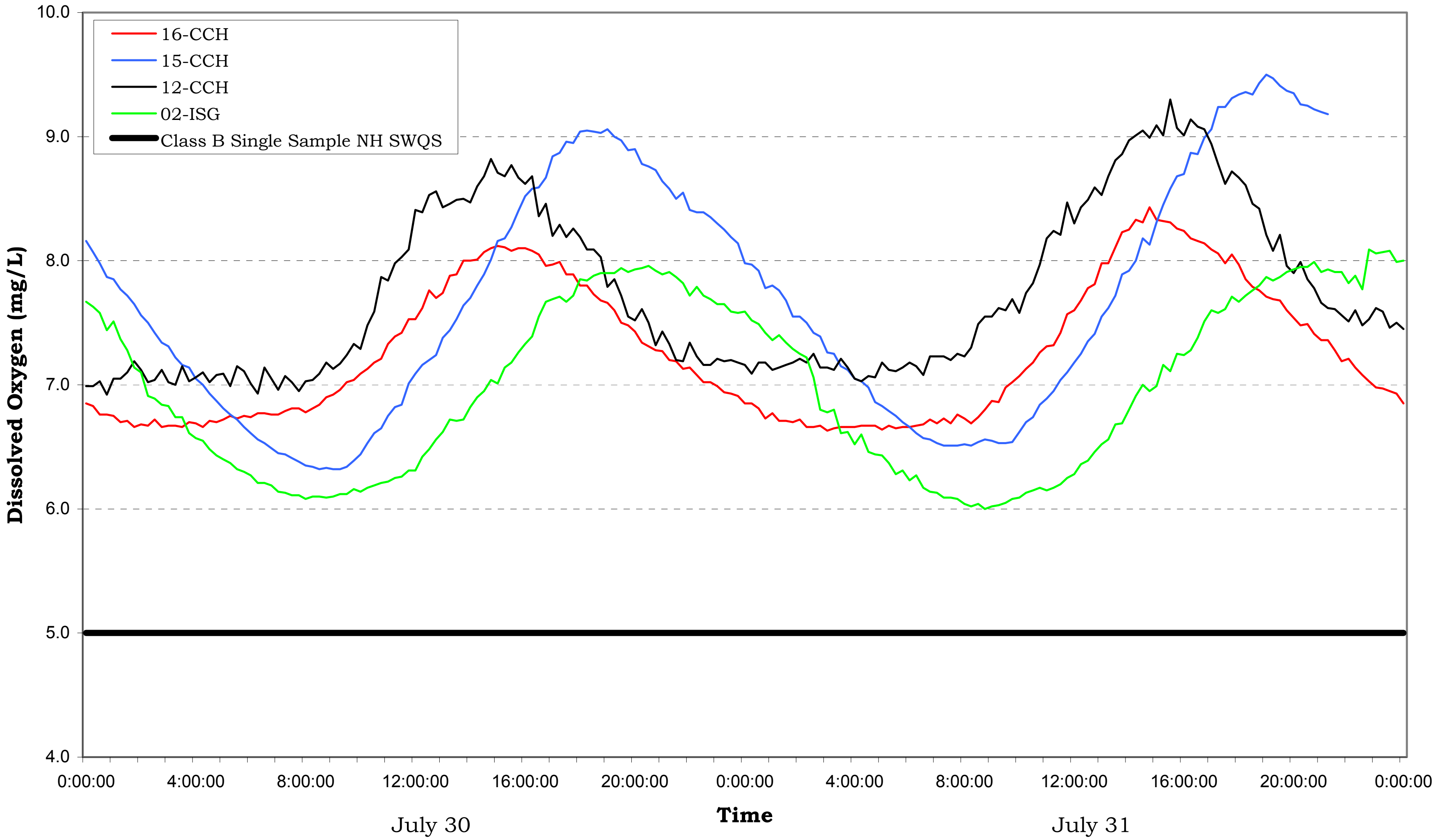


Figure 5-3. Dissolved Oxygen Concentration Statistics for the Cocheco and Isinglass Rivers July 30- 31, 2003, NHDES VRAP



5.2. pH

5.2.1. Results and Discussion

Between four and eight measurements were taken in the field for pH at ten stations on the mainstem of the Cocheco from Farmington to Dover. One sample was taken at four stations on the Mad River. (Table 5-2). All measurements but seven met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. The Class B New Hampshire surface water quality standard is 6.5-8.0, unless naturally occurring.

Table 5-2. pH Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
26-CCH	4	6.21 - 6.41	4	4
23-CCH	4	6.21 - 6.77	3	4
22U-CCH	5	5.23 - 6.4	5	5
22-CCH	8	6.24 - 8.22	5	7[a]
21-CCH	8	5.71 - 6.72	4	7[a]
19-CCH	8	5.11 - 6.92	3	7[a]
12-CCH	8	6.3 - 6.7	5	7[b]
11-CCH	8	6.19 - 7.3	3	7[b]
10-CCH	8	6.8 - 7.14	0	7[b]
07-CCH	8	6.33 - 7.1	1	7[b]
03-MAR	1	6.15	1	1
02-MAR	1	6.11	1	1
01-MAR	1	5.19	1	1
00-MAR	1	6.14	1	1
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**66**

[a] 9/22/03; Replicate and duplicate > .2 units from sample
[b] No duplicate or replicate taken on 8/25/03

A majority of the pH measurements in the Cocheco River watershed were outside of the range of the New Hampshire surface water quality standard (Figure 5-4). This is likely the result of natural conditions such as the soils, geology, or the presence of wetlands in the area. It should be noted that rain and snow falling in New Hampshire is relatively acidic, which can also affect pH levels.

Figure 5-5 illustrates the results of pH measurements obtained at four stations in the Cocheco River watershed using Hydrolab DataSonde 4a's. The meters were programmed to take pH readings every 15 minutes over a three-day period. The pH readings at three stations on the Cocheco River were within the water quality standard on all occasions during the two full days of data collected. A station on the Isinglass River (02-ISG) just before its confluence with the Cocheco was frequently below the minimum Class B standard of 6.5 units.

In general, pH increased downstream from Farmington to Dover. The pattern of increasing pH may be the result of a greater number of cations (positively charge elements such as sodium and calcium), which typically increase in urbanized areas. This can be related to the increased specific conductance levels found in the lower reaches of the river (see Section 5.4).

5.2.2. Recommendations

- Continue sampling at all stations; this will help to build a long-term data set to better understand trends as time goes on.
- Consider sampling for pH in some of the tributaries and wetland areas that are influencing the pH of stations with measurements below state standards. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes.* Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

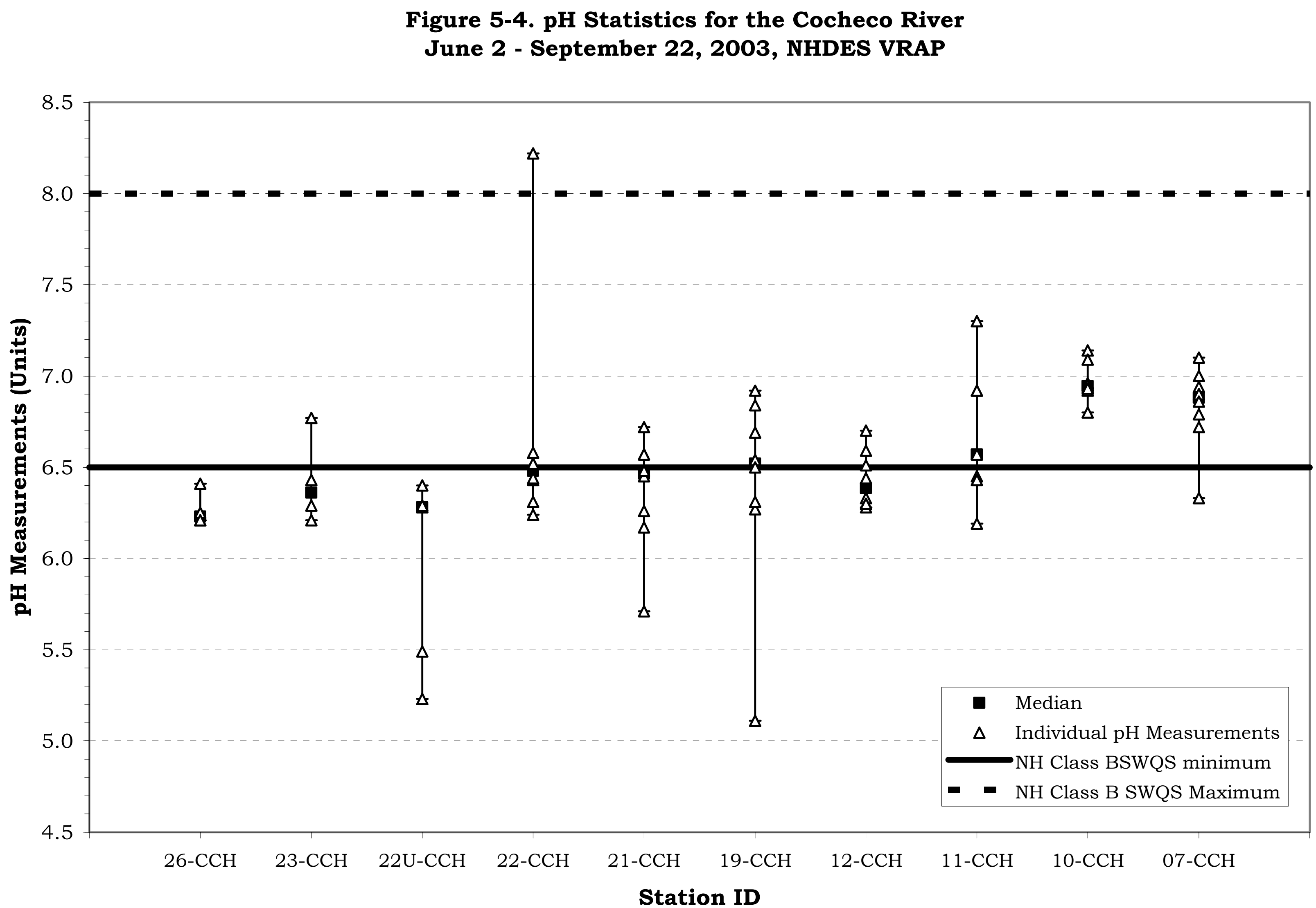
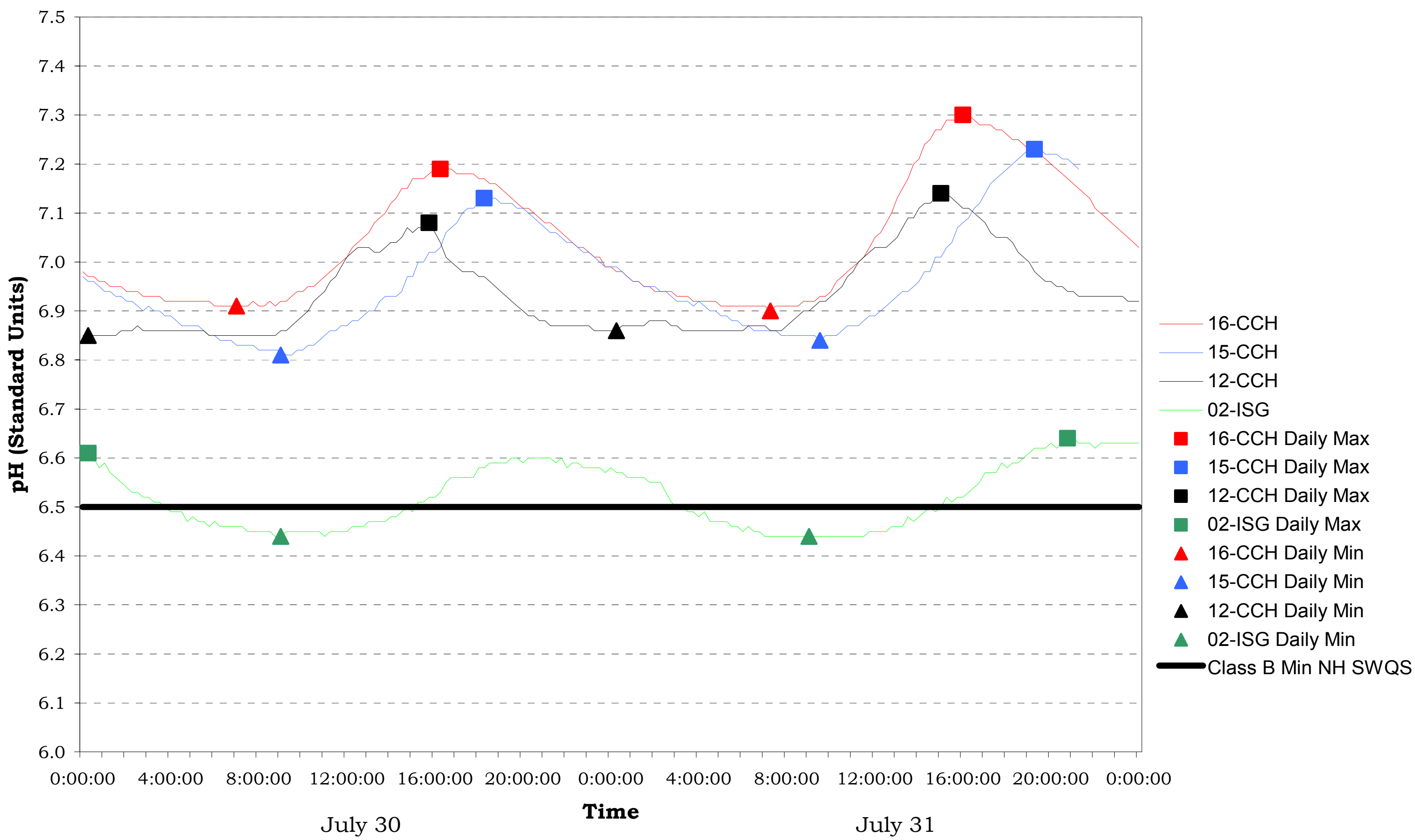


Figure 5-4. pH Statistics for the Cocheco River
June 2 - September 22, 2003, NHDES VRAP
pH Measurements (Units)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
26-CCH
23-CCH
22U-CCH
22-CCH
21-CCH
19-CCH
12-CCH
11-CCH
10-CCH
07-CCH
Station ID
Median
Individual pH Measurements
NH Class BSWQS minimum
NH Class B SWQS Maximum

Figure 5-5 pH Statistics for the Cocheco and Isinglass Rivers
July 30- 31, 2003, NHDES VRAP



5.3. Turbidity

5.3.1. Results and Discussion

Either five or six measurements were taken in the field for turbidity at ten stations on the mainstem of the Cocheco from Farmington to Dover [Table 5-3]. One sample was taken at four stations on the Mad River. All measurements but four met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. The Class B New Hampshire surface water quality standard for turbidity is less than 10 NTU above background.

Table 5-3 Turbidity Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (NTU)	Acceptable Samples Potentially Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
26-CCH	6	0.55 - 1.66	0	6
23-CCH	6	0.82 - 1.7	0	6
22U-CCH	6	0.9 - 5.14	0	6
22-CCH	6	1.5 - 3.0	0	6
21-CCH	6	1.6 - 2.82	0	6
19-CCH	6	3.52 - 6.0	0	6
12-CCH	5	2.6 - 6.6	0	4[a]
11-CCH	5	3.37 - 17.3	1[b]	4[a]
10-CCH	5	2.25 - 3.67	0	4[a]
07-CCH	5	2.3 - 3.9	0	4[a]
03-MAR	1	0.15	0	1
02-MAR	1	0.2	0	1
01-MAR	1	0.05	0	1
00-MAR	1	0.05	0	1
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**56**

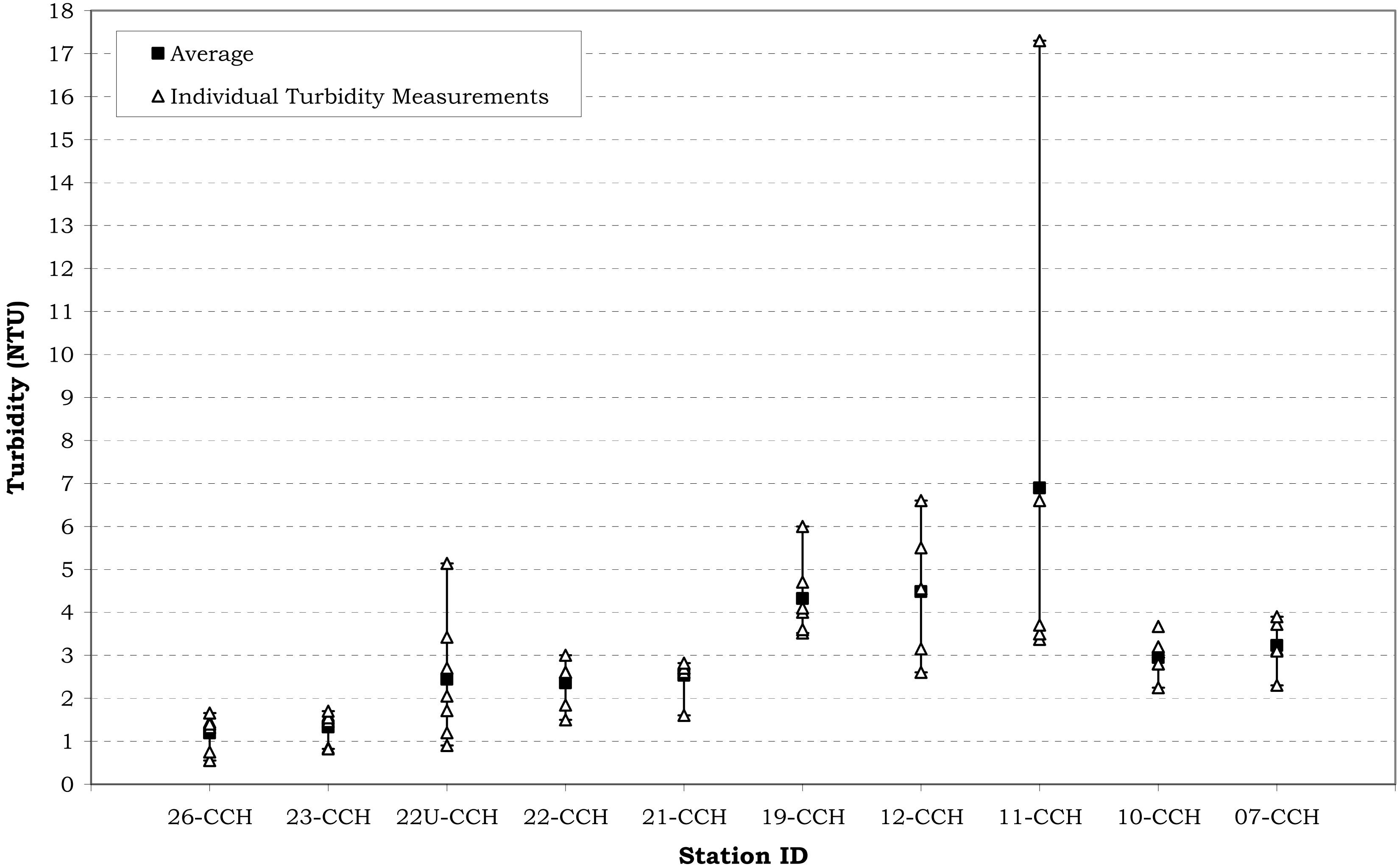
[a]No duplicate or replicate taken on 8/25/03
[b]Number of samples > 10 NTU over the lowest measurement of the season

Turbidity levels were low throughout the entire reach of river between Farmington and Dover except for single measurements at 11-Cch (Figure 5-6). In general it is typical to see a rise in turbidity in urban areas due to increased runoff. Turbidity levels during 2003 will be a useful indicator of the typical background conditions of the river.

5.3.2. Recommendations

- Continue sampling at all stations as this will help to build a long-term data set to better understand trends as time goes on.
- Collect samples during wet weather; this will help us to understand how the river responds to runoff and sedimentation.
- If a higher than normal turbidity measurement occurs, volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated turbidity levels. In addition, take good field notes and photographs.

Figure 5-6. Turbidity Statistics for the Cocheco River
June 2-September 22, 2003, NHDES VRAP



5.4. Specific Conductance

5.4.1. Results and Discussion

Either eight or nine measurements were taken in the field for specific conductance at ten stations on the mainstem of the Cocheco from Farmington to Dover [Table 5-4]. One sample was taken at four stations on the Mad River. All measurements but seven met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. A Class B New Hampshire surface water quality standard does not exist for specific conductance.

Table 5-4 Specific Conductance Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (µS/cm)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
26-CCH	9	86.2 - 154.3	Not Applicable	8[a]
23-CCH	9	97.6 - 206.4	N/A	8[a]
22U-CCH	9	101.7 - 341	N/A	8[a]
22-CCH	9	99.4 - 185.6	N/A	9
21-CCH	9	113.9 - 218.6	N/A	9
19-CCH	9	120.1 - 245.2	N/A	9
12-CCH	8	114.8 - 304.4	N/A	7[b]
11-CCH	8	133.2 - 288.5	N/A	7[b]
10-CCH	8	103.3 - 291.4	N/A	7[b]
07-CCH	8	102.6 - 288.8	N/A	7[b]
03-MAR	1	45.2	N/A	1
02-MAR	1	60.8	N/A	1
01-MAR	1	97.2	N/A	1
00-MAR	1	116.3	N/A	1
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**83**

[a]No duplicate or replicate taken on 8/11/03
[b]No duplicate or replicate taken on 8/25/03

Specific conductance levels were variable along the entire reach of the river (Figure 5-7). The influence of urbanization on specific conductance is apparent by the increased levels from the more rural upstream areas to the more urbanized areas in Rochester and Dover. Anions (negatively charged elements such as chloride) and cations (positively charged elements such as calcium) are typically found in rivers flowing through urbanized areas. Specific conductance generally increased in June and throughout the rest of the summer at all stations, likely because elevated river flows during early June diluted specific conductance levels.

Figure 5-8 illustrates the results of specific conductance measurements obtained at four stations in the Cocheco River watershed using Hydrolab DataSonde 4a's. The meters were programmed to take specific conductance readings every 15 minutes over a three day period. The average specific conductance levels increased significantly at 15-CCH approximately 1.5 miles downstream of 16-CCH and then leveled off again farther downstream at 12-CCH. Specific conductance levels were overall much lower at the station on the Isinglass River (02-ISG).

5.4.2. Recommendations

- Continue sampling at all stations as this will help to build a long-term data set to better understand trends as time goes on.

Figure 5-7. Specific Conductance Statistics for the Cocheco River
June 2-September 22, 2003, NHDES VRAP

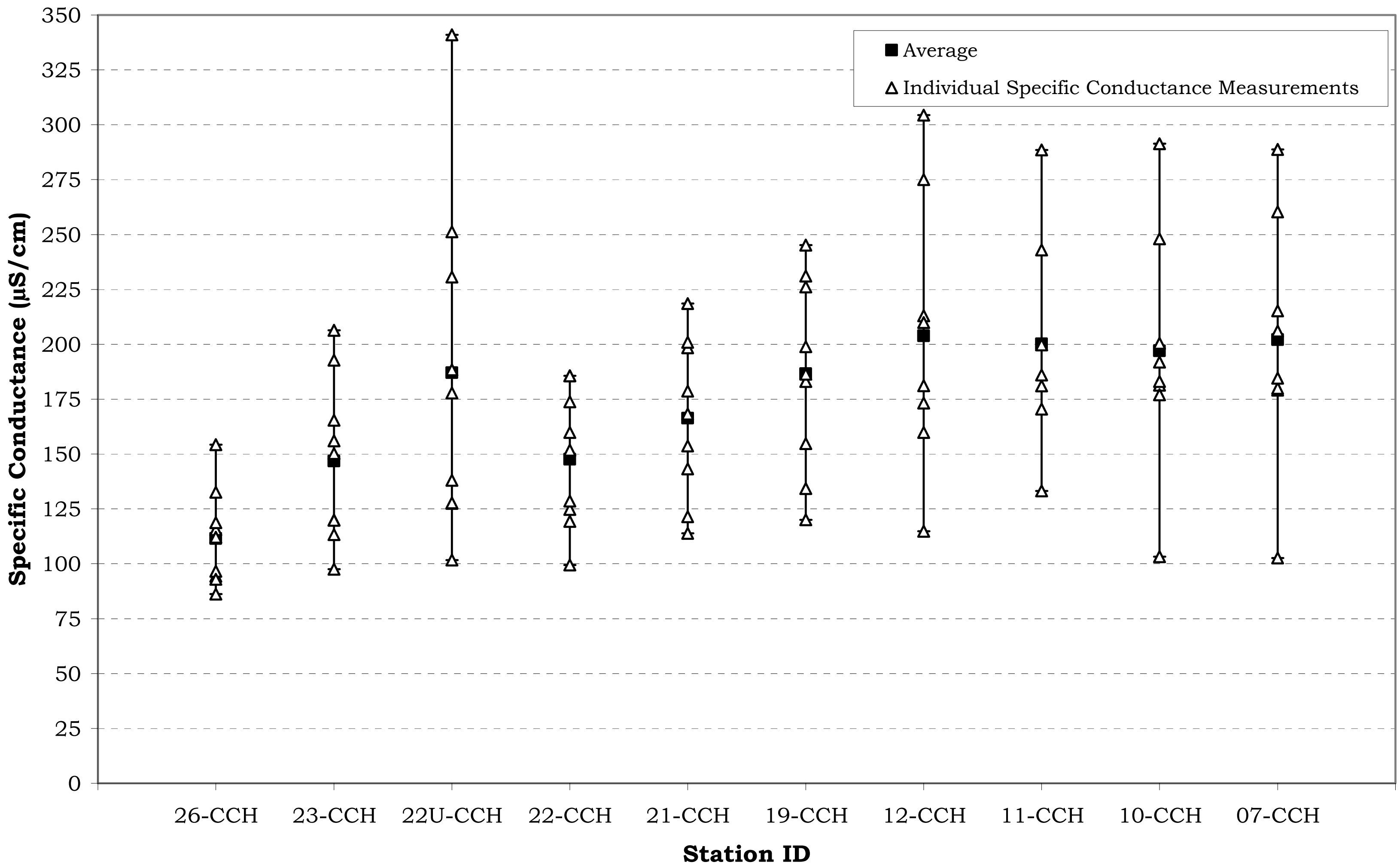


Figure 5-8. Specific Conductance Statistics for the Cocheco and Isinglass Rivers July 30- 31, 2003, NHDES VRAP

5.5. Bacteria/*Escherichia coli*

5.5.1. Results and Discussion

Four measurements were taken in the field for *Escherichia coli* (*E. coli*) at 10 stations from Farmington to Dover (Table 5-5). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. Class B NH surface water quality standards for *E.coli* are as follows:

<406 cts/100 ml, based on any single sample, or
<126 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

Table 5-5 *E. coli* Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (cts/100ml)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
26-CCH	4	120 - 1760	1	4
23-CCH	4	20 - >2000	1	4
22U-CCH	4	80 - 330	0	4
22-CCH	4	100 - 160	0	4
21-CCH	4	20 - 160	0	4
19-CCH	4	130 - 410	1	4
12-CCH	4	30 - 140	0	4
11-CCH	4	10 - 290	0	4
10-CCH	4	130 - 170	0	4
07-CCH	4	40 - 80	0	4
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**40**

Three of the nine stations tested for *E.coli* had single sample levels which exceeded the New Hampshire surface water quality standard (Figure 5-5). In order for a geometric mean to be computed three samples must be collected within a 60-day period. At all stations four measurements were taken over the course of the monitoring season. This allows DES to calculate a rolling geometric mean [Table 5-6]. As the table indicates a majority of the stations violated the standard of <126 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

Several factors can contribute to elevated *E. coli* levels, including, but not limited to rain storms, low river flows, the presence of wildlife (e.g., birds), and the presence of septic systems along the river.

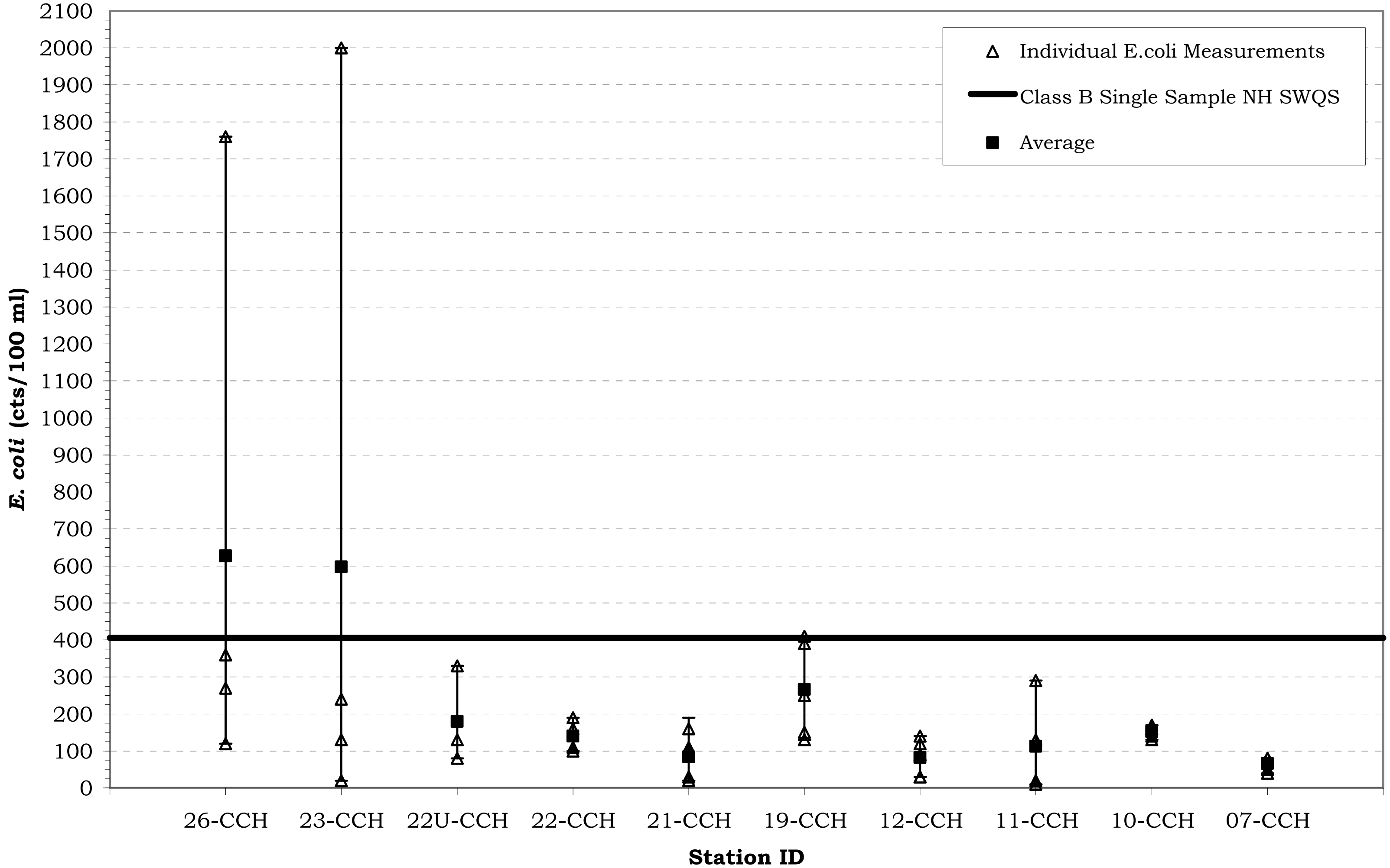
Table 5-6 Rolling geometric means for *E. coli* data, Cocheco River 2003, VRAP

Station ID	Geometric Mean 6/16/03 - 8/11/03	Geometric Mean 7/14/03 - 9/8/03	Geometric Means Not Meeting NH Class B Standards
26-CCH	424	555	2
23-CCH	397	213	2
22U-CCH	173	151	2
22-CCH	132	128	2
21-CCH	78	39	0
19-CCH	275	288	2
12-CCH	130	48	1
11-CCH	72	39	0
10-CCH	152	149	2
07-CCH	54	63	0

5.5.2. Recommendations

- Continue collecting three samples within any 60-day period during the summer to allow for determination of geometric means.
- Continue to document river conditions and station characteristics (including the presence of wildlife in the area during sampling).
- At stations with particularly high bacteria levels (i.e. 26-CCH), volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated bacteria levels. Those sampling should also look for any potential sources of bacteria such as emission pipes and failed septic systems.

Figure 5-9. *Escherichia coli* Statistics for the Cocheco River June 2-September 22, 2003, NHDES VRAP



5.6. Total Phosphorus

5.6.1. Results and Discussion

Four samples were collected for total phosphorous at 8 stations from Farmington to Dover (Table 5-7). All measurements met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. A numeric Class B NH surface water quality standard does not exist for total phosphorus. However, a total phosphorus concentration of 0.05 mg/L is used by NHDES as a level of concern and the agency pays particular attention to results above this level.

Table 5-7 Total Phosphorous Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
22U-CCH	4	0.056 - 0.081	Not Applicable	4
22-CCH	4	0.035 - 0.056	N/A	4
21-CCH	4	0.022 - 0.052	N/A	4
19-CCH	4	0.029 - 0.055	N/A	4
12-CCH	4	0.033 - 0.112	N/A	4
11-CCH	4	0.022 - 0.849	N/A	4
10-CCH	4	0.029 - 0.093	N/A	4
07-CCH	4	0.025 - 0.086	N/A	4
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**32**

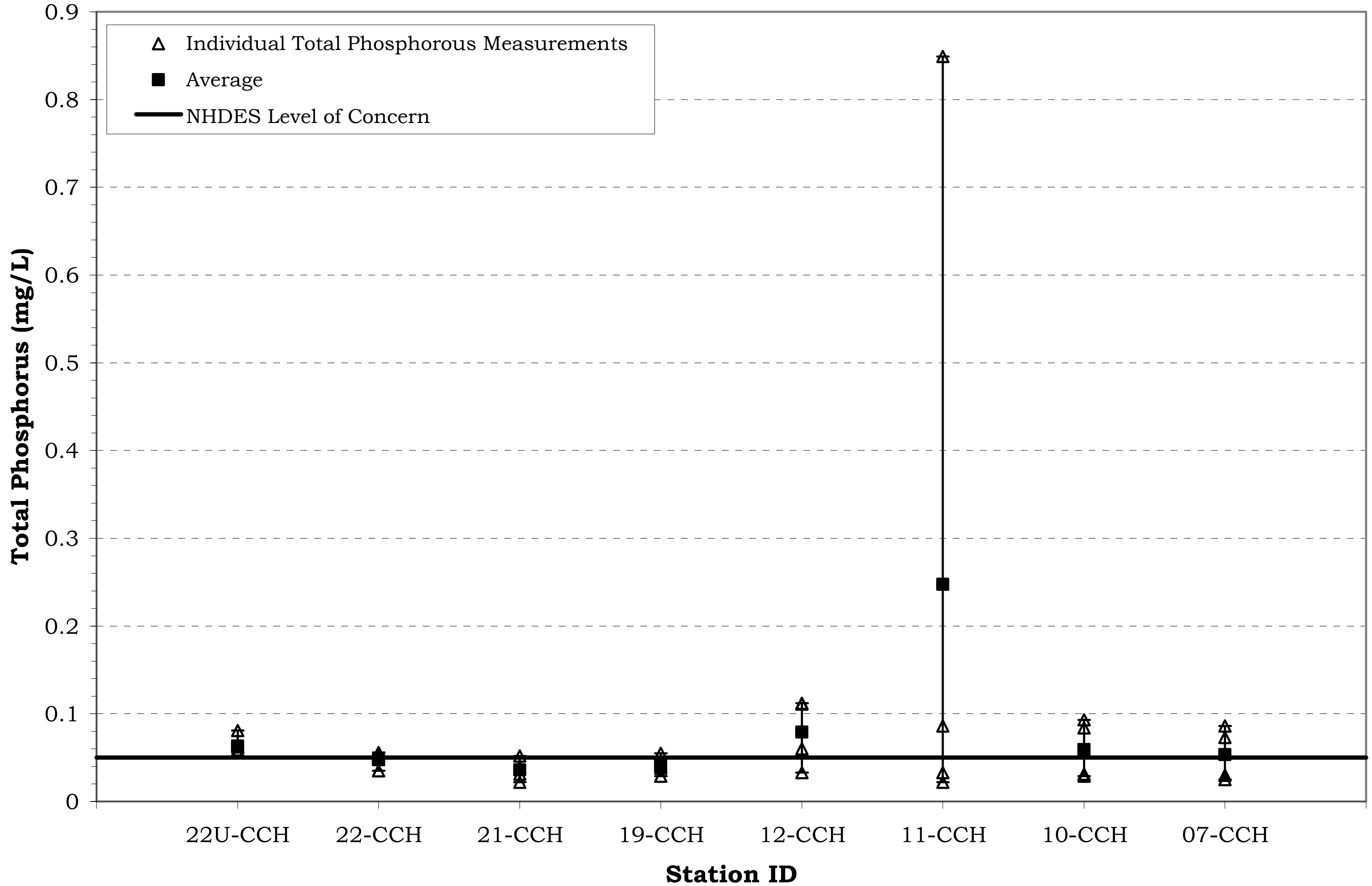
On at least one occasion at all stations the total phosphorous level did exceed NHDES's level of concern [Figure 5-10]. Under undisturbed natural condition phosphorous is at very low levels in aquatic ecosystems. Of the three nutrients critical for aquatic plant growth; potassium, nitrogen, and phosphorous, it is usually phosphorous that is the limiting factor to plant growth. When the supply of phosphorous is increased due to human activity algae respond with significant growth.

A major source of excessive phosphorous concentrations in aquatic ecosystems can be wastewater treatment facilities, as sewage typically contains relatively high levels of phosphorus detergents. However, fertilizers used on lawns and agricultural areas can also contribute significant amounts of phosphorus

5.6.2. Recommendations

- At stations with elevated total phosphorous levels, begin sampling for Chlorophyll-a. As mentioned above, high concentrations of phosphorous will lead to an increase in algal growth. Because algae is a plant and contains Chlorophyll-a the concentration of Chlorophyll-a found in the water will give an estimation of the concentration of algae. NHDES uses Chlorophyll-a as an indicator of total phosphorus levels and in the assessment of surface water for primary contact recreation.

Figure 5-10. Total Phosphorus Statistics for the Cocheco River
May 22-August 11, 2003 NHDES VRAP



5.7. Ammonia

5.7.1. Results and Discussion

Three samples were collected for ammonia (NH_3) at eight stations from Farmington to Dover (Table 5-8). All sample results met QA/QC requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. A numeric Class B NH surface water quality standard does exist for ammonia and is dependent on the pH (e.g for pH 6.5 the standard is <3.48 mg/L and for pH 7.0 it is <3.08 mg/L).

Table 5-8 Ammonia Data Summary for the Cocheco River 2003, VRAP

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
22U-CCH	3	<0.2 - 0.3	0	3
22-CCH	3	<0.2	0	3
21-CCH	3	<0.2	0	3
19-CCH	3	<0.2	0	3
12-CCH	3	<0.2	0	3
11-CCH	3	<0.2	0	3
10-CCH	3	<0.2	0	3
07-CCH	3	<0.2	0	3
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**24**

Ammonia concentrations were below 0.3 mg/L at all stations, which are extremely low and well below the standard. Ammonia can be a good indicator of recent pollution, such as that from agricultural runoff or problems with wastewater treatment systems. Through the process of ammonification amino acids are broken down by decomposer organisms to produce ammonia. During this process part of the ammonia is trapped in the soil and part of it is dissolved into water. Ammonia that is dissolved into water in the soil can make its way into surface waters through runoff during precipitation. This runoff will be significantly higher in more urbanized areas with a high amount of non-porous surfaces such as asphalt and pavement.

5.7.2. Recommendations

- Continue sampling at all stations; this will help to build a long-term data set to better understand trends as time goes on.

5.8. Nitrate/Nitrite

5.8.1. Results and Discussion

Two samples were collected for nitrate/nitrite (NO_3/NO_2) at 8 stations from Farmington to Dover (Table 5-9). All sample results met QA/QC requirements and are usable for New Hampshire's 2004 surface water quality report to the Environmental Protection Agency. A numeric Class B NH surface water quality standard does not exist for nitrate.

Table 5-9 Nitrate/Nitrite Data Summary for the Cocheco River 2003, VRAP

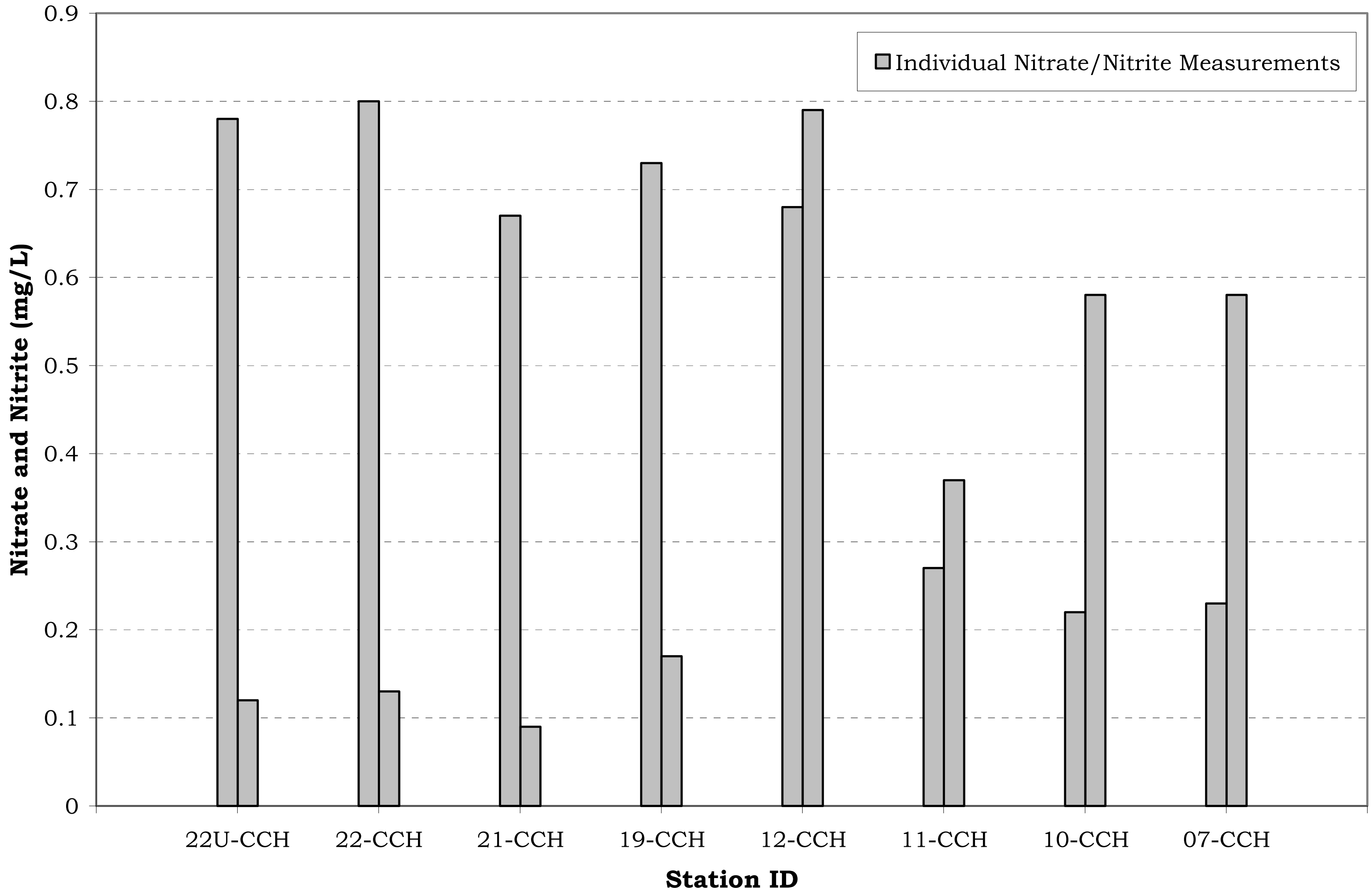
Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2004 NH Surface Water Quality Assessment
22U-CCH	2	0.12 - 0.78	Not Applicable	2
22-CCH	2	0.13 - 0.8	N/A	2
21-CCH	2	0.09 - 0.67	N/A	2
19-CCH	2	0.17 - 0.73	N/A	2
12-CCH	2	0.68 - 0.79	N/A	2
11-CCH	2	0.27 – 0.37	N/A	2
10-CCH	2	0.22 - 0.58	N/A	2
07-CCH	2	0.23 - 0.58	N/A	2
Total Number of Useable Samples for 2004 NH Surface Water Quality Assessment				**16**

Nitrate/nitrite concentrations did fluctuate with their highest concentrations occurring at 12-Cch [Figure 5-11). Nitrogen is naturally occurring in soil in organic forms from decomposing plant and animal matter. Bacteria in the soil then convert nitrogen to nitrate, a nitrogen-oxygen chemical unit. Primary sources which can cause increased nitrate levels are human sewage, livestock manure, and agricultural fertilizers. Higher nitrogen levels at some stations can likely be attributed to land and water management practices.

5.8.2. Recommendations

- Continue sampling at all stations; this will help to build a long-term data set to better understand trends as time goes on.

Figure 5-11. Nitrate and Nitrite Statistics for the Cocheco River
May 22-August 11, 2003 NHDES VRAP



APPENDIX
2003 COCHECO RIVER WATER QUALITY DATA